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A PRELIMINARY NOTE ON THE POSITION OF THE PRIMITIVE STREAK, AND ITS RELATION TO THE EMBRYO OF THE CHICK.

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At the end of the eighth to tenth hour of incubation of the hen's egg, the primitive streak begins to appear as an opaque line extending from the inner edge of the area pellucida to the center of the blastoderm. Between the tenth and eighteenth hours the primitive streak extends in length, until it covers a distance equal to two-thirds of the entire length of the area pellucida. While this increase in length is taking place the primitive groove forms, and at about the twentieth hour the head process is visible as a thickened line extending anteriorly from the primitive streak. I have endeavored to determine, experimentally, the direction of growth, and the exact position of the primitive streak in relation to the later embryo.

Assheton concluded from the results of his experiments that the central point of the area pellucida, before it becomes pear-shaped, represents the anterior end of the primitive streak, and that the latter develops "from the portion of the unincubated blastoderm which lies between the center of the blastoderm and the posterior margin of the area pellucida." Assheton does not mention the number of hours that the eggs were incubated, so that we do not know whether this central point represents the anterior end of the young primitive streak, or the point from which, later, the head process extends. His figures indicate, however, that the central point of the area pellucida represents the anterior end of the completely formed primitive streak of the eighteenth hour, before the head process appears.

In another series of experiments Assheton allowed the embryos to remain in the incubator twenty-four to forty hours after a sable hair had been inserted in the center of the unincubated blastoderm. In the embryos of twenty-four hours' incubation the hair was found at the anterior end of the primitive streak, the medul-

lary groove lying anterior to the hair. In those of forty hours' incubation the point of insertion lay at the level of the most anterior somites. The results of these experiments, as a whole, indicate that when the blastoderm of an unincubated egg is divided into two halves by a plane passed through the center, perpendicular to the long axis of the later embryo, the half anterior to this plane gives rise to the heart, brain, sense-organs, medulla and fore-gut, and all the rest of the embryo posterior to these organs arises through the activity of the primitive streak region.

The conclusions of Assheton are fully substantiated by the results of the experiments which I made in 1898, although at that time I used embryos in which the primitive streak was already present, or completely formed. I found that an injury made at the anterior end of the primitive streak of the eighteenth hour of incubation, appeared in forty-eight hours in the region just back of the heart, between the first pairs of somites.

Kopsch has recently described (1902) a series of experiments which he made in order to determine whether or not the actual cell material of the primitive streak becomes changed into the embryo. This, he concludes, is true, and he is able to show, through these experiments, that the primitive streak represents definite parts of the embryo. The most anterior end becomes the chordal region of the head, from the middle portion the somites and trunk develop, and from the posterior third the parts of the embryo caudal to the twentieth pair of somites are formed. He believes that the young primitive streak represents these regions in greater concentration. Thus, the entire embryo with the exception of the pre-chordal head area arises directly from the cell material of the young primitive streak.

Kopsch recognizes, as all must who attempt experiments on the early embryo of the chick, the great difficulties arising from the variation in degree of development at a given hour, and also the great danger, in the living egg of failure in locating the exact region that is to be injured. These difficulties may account in part for the difference in the results obtained by Kopsch, and by Assheton and myself.

In the spring of 1902 I made a series of experiments in

which I used Kopsch's method of injuring certain regions by the introduction of electrodes instead of cauterizing with a hot needle. I was not so successful with this method as I have been with the hot needle. I repeated my own experiments in which the anterior end of the primitive streak of eighteen hours had been killed, and obtained the same result as before; the injury appeared after twenty-four to forty-eight hours in the region of the anterior somites. Kopsch did not injure the anterior end of the primitive streak of an embryo younger than twenty-four hours. He found that an injury made at the anterior end of the primitive streak at this time appears after incubation in the brain, greatly disturbing the development of that region. From this he concludes that the anterior end of the primitive streak represents the chordal region of the head. I have found that an injury made in the area pellucida immediately *in front* of the primitive streak of eighteen hours, appears in this region of the head. It seems reasonable, therefore, to conclude that Kopsch has injured the head process instead of the primitive streak, for by the twenty-fourth hour the former is fully developed.

I can not understand how Kopsch is able to locate the anterior end of the primitive streak in a twenty-four-hour embryo, for eggs incubated in the laboratory at Bryn Mawr, and in my own laboratory in Baltimore, at twenty-four hours show the medullary folds, the first pair of somites, and the notochord; moreover, in the living egg it is almost impossible to determine where the primitive streak ends and the head process begins. After the twentieth hour I have found it impossible, unless development has been delayed, to locate the anterior end of the primitive streak.

I have repeated Kopsch's experiment, and have intentionally injured the distal end of the head process. At the end of twenty-four to forty-eight hours the injured region has been found in the brain, in a position corresponding to that indicated by Kopsch as the result of supposed injury to the anterior end of the primitive streak. If Kopsch had experimented on an embryo of the age indicated by his figures for sixteen and a half

hours, I think he would undoubtedly have found that the anterior end of the primitive streak does not, in the later embryo, represent a region beyond the anterior somites, and therefore, does not take part directly in the formation of organs anterior to the heart.

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